Minnegram Summer 2013

Director's Corner

- Summer 2013 Director's Corner

Features

- Minnesota's increasing weather extremes will demand smarter water resources management, says state climatologist, weather historian Mark Seeley

  Minnesota's reputation for weather extremes will intensify with climate change, bringing more extreme variation in the drought and flood cycle. And it's a trend that will have an enormous impact on the state's water resources management, says climatologist Mark Seeley.

- Predicting aquatic plant growth in the St. Louis River Estuary

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- Can enhanced street sweeping be a cost-effective way to reduce urban stormwater P loads?

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- Adaptive management strategies in the United States Army Corps of Engineers - an analysis

  Recently the USACE called upon a group of researchers, including Dr. Deborah Swackhamer and Marc Dettman from the University of Minnesota, to determine how adaptive management is currently being utilized in the USACE, and also to make recommendations for improving adaptive management practices within the USACE. The research team conducted several interviews of USACE personnel in an effort to determine how adaptive management is being used in a variety of USACE natural resource management projects.

News

- Summer 2013 Legislative Update

  While the news from Washington was unpleasant, the news from St Paul was much better. The U.S. Geological

Survey (USGS) decided to keep 50% of our current fiscal year funding as part of the sequester budget cuts, to stave off furloughs of their employees. It meant we could not fund all our research projects, and affected student funding. In addition, the USGS cancelled this year's national competitive grants program. We are working hard to have the Congress reinstate full funding of the national Water Resources Research Institute program in FY14. Any support you might offer to your senators or representative would be appreciated!

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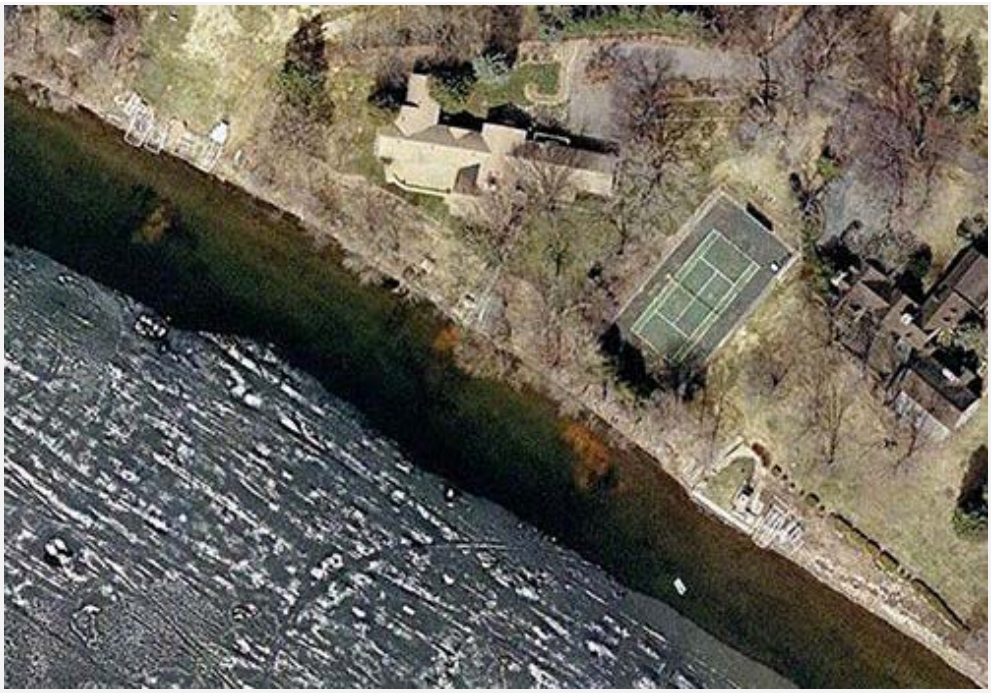
The Silver Lining of White Bear Lake

The past year has seen a remarkable rise in interest in our state's groundwater resources. One of the reasons is the cautionary tale of White Bear Lake, whose water level has dropped six feet over the last decade. A thorough study of groundwater movement in the White Bear Lake area by the USGS revealed that the lake drains to underlying aquifers. Drawdown of the Prairie du Chien - Jordan aquifer complex by increased pumping by an expanding suburban population is the main contributor to the drop in the lake levels. White Bear Lake is iconic, one of the largest and deepest in the Metro area and heavily used for recreation. It's visibility and value brought the concept of surface water and groundwater connections to the public, and it is now clear that White Bear Lake is not alone - sixteen other communities and their surrounding areas in the Metro and around the state are experiencing similar drawdowns of their groundwater due to over pumping.

The Freshwater Society and the Met Council recently issued informative reports for the public on groundwater. The DNR just named its first Groundwater Management Area. The Legislature's actions this session demonstrated their understanding of this problem - both the House and Senate had informational hearings on groundwater sustainability, and several statute changes and the appropriations



The inflowing groundwater has abundant iron and little oxygen before it enters the lake. As the groundwater flows into the lake, the water becomes oxidized, and iron precipitates out of the water, forming the iron stains seen above near the shoreline.

Photo credit: Perry Jones USGS

of the Clean Water Fund (see Legislative Update) reflect this interest. The 2011 Minnesota Water Sustainability Framework placed the need for abundant clean water at the top of the list of the Ten Big Issues to address, and it is gratifying to see that the public and decision makers are recognizing that surface water and ground water are all part of one system, one hydrosphere.

It is gratifying to see people taking steps to understand groundwater and surface water interactions, so that all water can be managed sustainably. And it is gratifying to see that, as part of the sustainability conversation, people are talking seriously of conservation, price incentives, and water reclamation strategies. Minnesotans are no longer taking their water for granted; they are taking stewardship.

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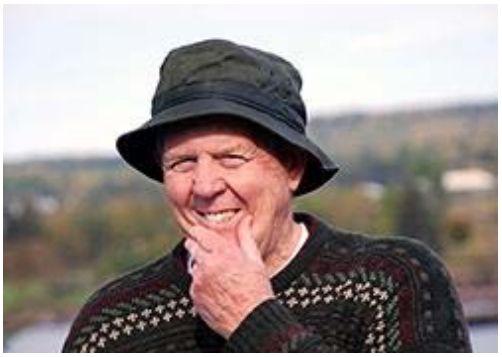
nnesota’s increasing weather extremes will demand smarter water resources management, says state climatologist, weather historian Mark Seeley

By Nina Shepherd



Minnesota’s reputation for weather extremes will intensify with climate change, bringing more extreme variation in the drought and flood cycle. And it’s a trend that will have an enormous impact on the state’s water resources management, says climatologist Mark Seeley.

A professor in the University of Minnesota’s department of Soil, Water, and Climate and Minnesota Extension and a graduate advisor in the Water Resource Sciences Graduate Program, Seeley is Minnesota’s most recognized expert on weather trends. His ability to explain the complexities of climate change’s impact on weather with down-home charm has made him a popular media commentator and speaker at convocations, workshops and special events throughout the region.

So when Seeley speaks on the coming effects of climate change, he isn’t shrill, but his warning is dire.

Floods and droughts are nothing new to Minnesota. In fact, Seeley says, “drought is a marker of our state.” But, he points out, the historical record and recent models show that Minnesota’s drought and flood cycles are getting wilder and more severe.

Unlike the multi-year drought that’s gripped the desert southwest, Minnesota’s recent droughts have been generally been alleviated by wet springs. As an example, last fall’s drought—during which 84 percent of Minnesota was in drought—was quickly quelled by this year’s late winter snows and record-breaking spring rainfalls.

“We snapped back in a hurry, and so dramatically, that this past spring has been the wettest in Minnesota history,” says Seeley. “When our environment is too wet or too dry, we wait for the other pattern to emerge and when it does it happens emphatically.”

Those wild swings are due to what Seeley calls ‘massive alleviation’ — a weather phenomenon that’s akin to applying a tourniquet to a paper cut.

“More of our precipitation is coming in the form of intense thunderstorms,” says Seeley. “Additionally, he says, there’s high spatial probability in these storms, meaning they can miss entire counties, creating huge disparities in rainfalls within a single region.”

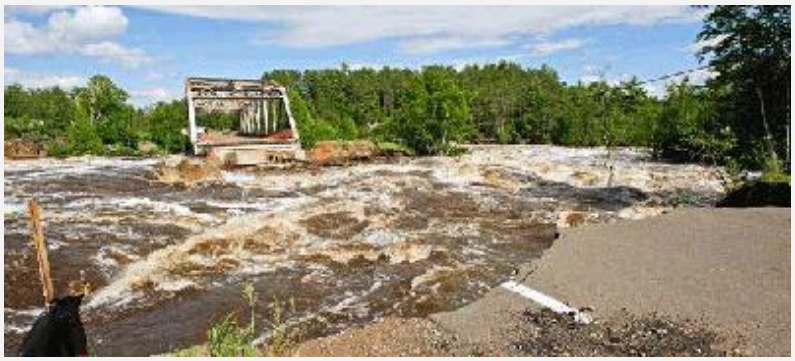
As an example, he points to the summer of 2007 during which 24 Minnesota counties received drought designation by the U.S. Department of Agriculture. The same summer, seven Minnesota counties were declared flood disasters by the Federal Emergency Management Agency.

“At first, we thought that vast discrepancy was a singularity, a sample of one,” says Seeley. But the same thing happened in 2012, when 55 Minnesota counties received federal drought designation at the same time 11 countries declared flood emergencies. “Two times in ten years is no longer a singularity,” he says.

In fact, Seeley believes it’s the start of a long-term trend of increasingly intense and spatially fragmented thunderstorms—the kind of storms that can wipe out entire landscapes—like what happened along the St. Louis River in Jay Cooke State Park last June. With the kind of flooding that can wash away roads and bridges, natural ecosystems, and a season’s worth of crops.

The trend is particularly pronounced in the western Great Lakes region, and Seeley says, nowhere else are the variations as extreme as they are in Minnesota.

“We’ve got to figure out how to find ways to be more flexible and resilient in our water resource management,” he says. “The staggering costs of damage alone will force us to change our behavior and approach to water management. “



June 2012's torrential rains devastated landscapes and wiped out the Highway 210 approach to the Thomson Bridge in Jay Cooke State Park, 10 miles southwest of Duluth.

Photo credit: Minnesota Department of Transportation.

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dicting aquatic plant growth in the St. Louis River Estuary

By June Kallestad

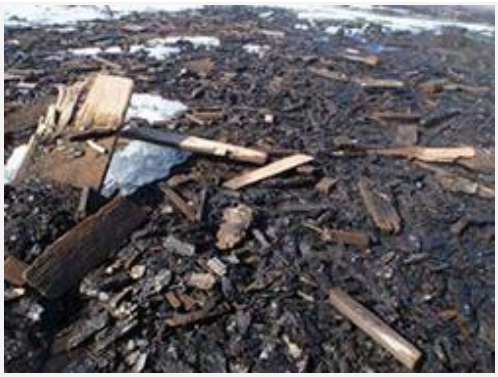
There's a place in the Duluth-Superior St. Louis River Estuary some call "Coffee Ground Flats" because the bottom of this aquatic ecosystem is covered with a deep layer of century old dark brown wood chips. In the 1800s, thriving sawmill owners used the estuary as a convenient place to dispose of wood waste.

Today's effort is to reverse the damage from that and other past industrial practices that have made some areas of the estuary unsuitable for marine life. NRRI is putting their computer modeling talents to work to help the cause. Funded by the U.S. Fish and Wildlife Service, NRRI scientists are generating simulation models to predict where aquatic vegetation will regrow if certain restoration practices – like islands or artificial reefs – are applied.

If the plants come back, so will the bugs and the fish and the birds… the goal is to develop an 'ecological design' for restoration after the sediments have been cleaned up.

NRRI researchers have collected data at former industrial sites at 21st and 40th Avenues West in Duluth. Their survey includes plants, bugs and birds currently living there, as well as the area's underwater topography and wave energy. A variety of computer simulated islands will be modeled to predict if large scale engineering in the so-called "area of concern" will help break up the wave action and allow more wetland and other aquatic plants to grow.

"This will give the planners an idea of what to expect under different restoration scenarios," George Host, NRRI GIS Lab Director, explained. "It adds solid science to the decision making process."



Wood and sawdust debris at the bottom of the bay create unfavorable habitat for fish and other wildlife.

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n enhanced street sweeping be a cost-effective way to reduce urban stormwater P loads?

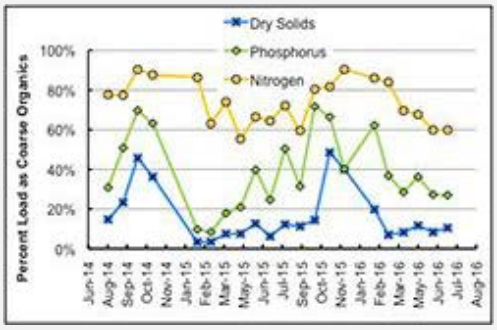
By Larry Baker

Throughout Minnesota, cities struggle with the goal of reducing nutrient inputs to urban lakes. The nearly completed Prior Lake Street Sweeping Study took a new look at an old practice, examining the potential of enhanced street sweeping as a source reduction BMP. The study is unique in several aspects: (1) it examined the effect of both percentage tree canopy and sweeping frequency (once, twice, and four times per month); (2) sweeping was done from snowmelt through snowfall, and therefore included autumn leaf fall (most previous studies did not); (3) tree leaves were analyzed separately from the finer sediments; and (4) costs were computed for each of nearly 400 sweeping runs.

The sweeping design was developed by Ross Bintner, formerly the Water Resources Engineer at the City of Prior Lake (now at the City of Edina). The University of Minnesota research team was led by Larry Baker (Bioproducts and Biosystems Engineering, BBE) and Sarah Hobbie (Ecology, Evolution, and Behavior, EEB), with funding provided by EPA's Nonpoint Source Program, via the Minnesota Pollution Control Agency. Technician Chris Buyarksi led the analytical effort.

Preliminary findings, to be incorporated into a thesis by BBE graduate student Paula Kalinosky, show that the quantities of dry solids, phosphorus, and nitrogen removed increase with tree canopy and frequency of sweeping. For example, sweeping high canopy streets four times each month removed 3.9 times more phosphorus than sweeping low canopy streets once per month. Removal of nutrients followed a seasonal cycle, with larger quantities of nutrient removal during the spring and fall. For high canopy streets, 70-80% of the nitrogen and phosphorus removed during the spring and fall peaks was contained in the "coarse organics" – tree leaves, seeds, and other vegetative debris (see Figure 2). The economics also appear quite favorable: under certain circumstances (e.g., during fall and for streets with high canopy cover), the cost of P removal was less than $20 per pound but typically $40-50/lb P removed during the fall peak for higher canopy, compared with typical

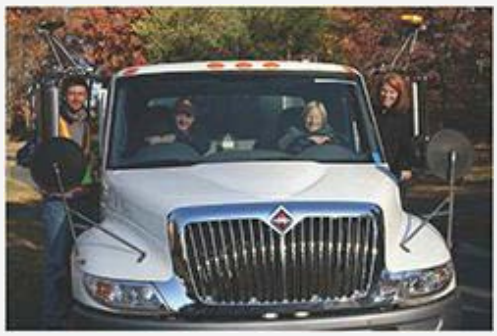
values of several hundreds of dollars per pound for stormwater ponds.



Coarse organic material (mainly leaves) as a proportion of total sweeping load (monthly average values, high canopy sweeping routes), Prior Lake, MN

Results are being incorporated into an online spreadsheet planning tool that will allow public works departments to estimate potential nutrient and solids removals under various sweeping scenarios. The spreadsheet tool, along with final project findings, will be presented in several workshops to be held in July and August of 2013. Results will also be presented at the 2013 Low Impact Development Conference, being held August 8-13, 2013.

Proposed follow-up research will (1) determine the effectiveness of enhanced sweeping for other cities in Minnesota; (2) predict improvements in lake clarity under various sweeping regimes; and (3) optimize street sweeping, to achieve maximum benefits at minimum cost.



The project team, left to right: Ross Bintner, Chris Buyarksi, Sarah Hobbie, and Paula Kalinosky (not shown: Larry Baker).

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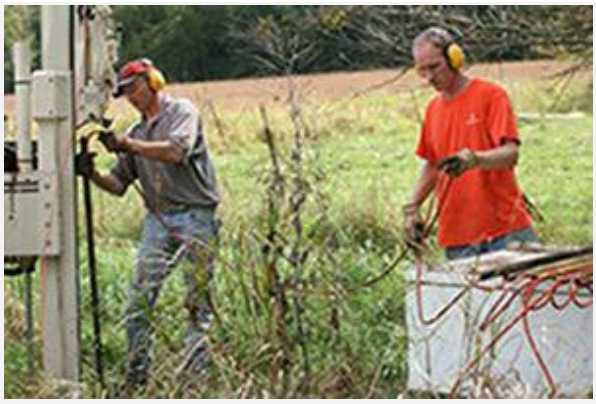
ctoral Dissertation Fellowship recipient Scott Kronholm suggests long-term thinking and patience through his nitrate concentration research

Scott Kronholm's fascination with the flow of water began with childhood days spent on the shores of his home on Lake Vermilion. There he had access to all nature had to offer, dirt, bugs, rocks and water. These days, in the final year of his doctoral studies with the Water Resources Science (WRS) program, Kronholm's dissertation, "Spatial and Temporal Variability of Nitrate Concentration in diverse Agricultural Streams" also follows the path of water, this time as it transports nitrates.

As water flows, so do pollutants, sometimes flowing freely over a surface and directly into a water body, or perhaps soaking deep into the groundwater, not to resurface until 50 years or more in the future. Thus, measurable results from efforts to curb nitrate levels in water bodies may also not be seen for years. Kronholm wants to encourage patience when waiting for positive results. "Flow paths determine the length of time from fertilizer application to introduction of excess fertilizer into a stream bed," says Kronholm, who hopes that his research will create realistic expectations within the farming community and regulatory agencies. High nitrate levels that were years in the making will take years to abate. Kronholm, who was recently awarded the Doctoral Dissertation Fellowship, feels that farmers are often given a bad rap, when many farmers are trying BMPs voluntarily, often at their own expense. "Hopefully, my research will help scientists, legislators, famers and other stakeholders set realistic goals and expectations for reducing nitrate levels in our water."

Kronholm is grateful to receive the fellowship, which will in part fund travel to conferences this upcoming year, and he had this to say about his experience in the WRS program, "I really liked the WRS graduate program; it offers a broad brush stroke of learning by showing you how your specific studies relate to everything else, biology, the physics of water, politics and policy. Sure, it's complicated, but that's my message, 'don't get discouraged if you have to wait for results.'"



Kronholm and Erik Smith collecting soil core samples in a corn field near Blairsburg, IA

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aptive management strategies in the United States Army Corps of Engineers - an analysis

By Scott Kronholm

Within the United States Army Corps of Engineers (USACE), there has been an increased effort to utilize adaptive management strategies in a variety of ecosystem restoration projects. In this context, adaptive management refers to an iterative form of natural resource management that involves the testing, monitoring, and evaluation of applied strategies, followed by the incorporation of newly learned knowledge into future management decisions. As it becomes more difficult and costly to predict what ecosystems will look like in the future, adaptive management provides a set of methods for improving flexibility and learning when creating management plans and policies. That flexibility will be important as managers identify and face current and future challenges to sustainable use of water resources.

Recently the USACE called upon a group of researchers, including Dr. Deborah Swackhamer and Marc Dettman from the University of Minnesota, to determine how adaptive management is currently being utilized in the USACE, and also to make recommendations for improving adaptive management practices within the USACE. The research team conducted several interviews of USACE personnel in an effort to determine how adaptive management is being used in a variety of USACE natural resource management projects.

The responses from the interviewees highlighted some processes that facilitate and improve the usefulness of adaptive management. For example, there are currently a number of reports available to the USACE that can serve as examples of adaptive management in action. These reports offer some guidance toward implementing adaptive management in natural resource management projects. Skilled staff that have experience with adaptive management was also mentioned as an extremely important piece of the adaptive management process. However, in the event that trained and experienced staff members are unavailable, there is the potential to bring in external experts who can aid in the adaptive management

process. Stakeholder involvement can also facilitate adaptive management by bringing in local knowledge, assisting in long-term monitoring, and providing timely information back to the managers.

Home > Publications > Minnegram Online > Summer 2013 > Adaptive management strategies in the United States Army Corps of Engineers - an analysis Minnegram Adaptive management strategies in the United States Army Corps of Engineers - an analysis By Scott Kronholm Within the United States Army Corps of Engineers (USACE), there has been an increased effort to utilize adaptive management strategies in a variety of ecosystem restoration projects. In this context, adaptive management refers to an iterative form of natural resource management that involves the testing, monitoring, and evaluation of applied strategies, followed by the incorporation of newly learned knowledge into future management decisions. As it becomes more difficult and costly to predict what ecosystems will look like in the future, adaptive management provides a set of methods for improving flexibility and learning when creating management plans and policies. That flexibility will be important as managers identify and face current and future challenges to sustainable use of water resources. Recently the USACE called upon a group of researchers, including Dr. Deborah Swackhamer and Marc Dettman from the University of Minnesota, to determine how adaptive management is currently being utilized in the USACE, and also to make recommendations for improving adaptive management practices within the USACE. The research team conducted several interviews of USACE personnel in an effort to determine how adaptive management is being used in a variety of USACE natural resource management projects. The responses from the interviewees highlighted some processes that facilitate and improve the usefulness of adaptive management. For example, there are currently a number of reports available to the USACE that can serve as examples of adaptive management in action. These reports offer some guidance toward implementing adaptive management in natural resource management projects. Skilled staff that have experience with adaptive management was also mentioned as an extremely important piece of the adaptive management process. However, in the event that trained and experienced staff members are unavailable, there is the potential to bring in external experts who can aid in the adaptive management process. Stakeholder involvement can also facilitate adaptive management by bringing in local knowledge, assisting in long-term monitoring, and providing timely information back to the managers. Many interviewees mentioned that although there are things in place that can aid adaptive management, it is still having trouble gaining traction within the USACE. The barriers to adaptive management identified by the interviewees did not make the process impossible, but did limit its effectiveness. Mentioned among all interviewees was a lack of coherent message on how to properly implement adaptive management in USACE natural resource management projects. This resulted in some USACE districts developing their own guidance for adaptive management, and other districts disregarding the use of adaptive management almost entirely. Budgetary limitations were also mentioned commonly in interviews as a barrier to successful adaptive management. This was especially true with regard to the mandatory 10 years of environmental monitoring required within adaptive management projects. Many people within the USACE and in congress prefer new projects over monitoring existing projects. And, the large natural variability contained within these projects leads to higher monitoring costs, further exacerbating the issue. Regulations and laws were found to increase coordination time and complexity of projects utilizing adaptive management. Ideally teams implementing adaptive management would be small. However, due to the complexity resulting from the regulations and necessary interactions these teams often are quite large and complex, which increases cost and decreases flexibility and responsiveness of the process. For example, local cost sharing is a requirement of USACE projects, but the adaptive management concept makes it harder to sell a project to local

partners due to the perceived extra expense. This often has the effect of turning stakeholders off to the idea of adaptive management. On top of that, there is currently no guidance for engaging stakeholders within the adaptive management framework. The high staff turnover rate within the USACE was also mentioned as an issue that impedes adaptive management, because an experienced staff is vital to successful adaptive management. As trained staff members leave, the lessons and skills for implementing adaptive management have to be re-learned by new members. Lastly, several interviewees mentioned the tension that arises between the congressionally mandated short-term progress and the long-term response of an ecosystem to an adaptive management project.

The researchers evaluated the responses from all interviewees and created five key recommendations for the USACE to consider in an effort to increase the use and success of adaptive management. The first recommendation is for the USACE to develop a set of common reference materials regarding adaptive management, to disseminate those materials throughout the USACE, and to reinforce their commitment to adaptive management regularly. Securing long term funding for the successful implementation of adaptive management is the second recommendation set forth by the research team. In particular, they suggest that the USACE work with other agencies to identify and leverage resources, and develop relationships with the private sector to identify cost sharing opportunities. The researchers also suggest developing training and mentoring programs in an effort to retain the information necessary for adaptive management within, and distributed throughout the USACE. The fourth recommendation is for the USACE to conduct advocacy and awareness campaigns within the district offices. This will help to promote inter-office dialog, sharing of new techniques and knowledge, and standardization of adaptive management terms and methods. Lastly, the research team suggests that the USACE coordinate and collaborate with other agencies on approaches to adaptive management. This will help with communicating the ideas and benefits of adaptive management to a wide range of stakeholders, as well as to congress.

Although several barriers remain, adaptive management is catching on within the USACE and is being incorporated into the planning stages of projects in an effort to address uncertainty and risk early on. Communication within the USACE regarding adaptive management has increased which has led to the sharing of ideas and best practices for use within the adaptive management framework. Seeing as climate change will likely increase the level and scale of uncertainty in the future, adaptive management will offer the USACE a strong footing as they move forward with natural resource management projects.

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mmer 2013 Community News

Larry Baker (WRS faculty, BBE) chaired a National Academy of Sciences-sponsored workshop "Regional Approaches to Urban Sustainability: A Focus on Portland", May 28-29, 2013 at Portland State University. Baker also spoke at Northeastern University, Boston, MA, March 19, 2013 on "Mass Flow Analysis of Nutrients in Urban Ecosystems," Baker and Heidi Peterson presented "Phosphorus balance for the Albert Lea watershed," at the Shell Rock River Watershed District, Albert Lea, MN, March 13, 2013.

John Gulliver (WRS faculty, CE) is on the organizing committee for the 2013 International Low Impact Development Symposium, which will take place in Saint Paul, Minnesota, August 18-21, 2013, brings together over 1,000 professionals to share their research, implementation, policy, financing and education strategies to build and restore cities while protecting our environment. The Symposium seeks to advance the knowledge and understanding of sustainable LID principles and practices for stormwater, and is being hosted in 2013 by the University of Minnesota.

George Host (WRS Faculty, NRRI) along with Gerry Sjerven and Norman Will (NRRI) recently published a map-based website to deliver information and data sets relevant to coastal communities of Minnesota's Lake Superior North Shore. Resources include real-time information on weather, traffic and beach conditions, live-streaming Twitter feeds, along with map information on recreational opportunities, population and land cover. The project was funded in part under the Coastal Zone Management Act, by NOAA's Office of Ocean and Coastal Resource Management, in cooperation with Minnesota's Lake Superior Coastal Program. The site can be found at www.nrri.umn.edu/CoastalGIS/WebPortal.

Tim LaPara (WRS Faculty, CE) will assume the duties of DGS for the Water Resources Science program July 1, 2013.

Deb Swackhamer (WRC co-director) was reappointed as the Higher Education representative to the Clean Water Council. The Clean Water Council was created in 2006 by the Clean Water Legacy Act, and charged with advising the Governor and Legislature on the Clean Water Fund created by the Clean Water Land and Legacy Amendment to the Constitution. This is a

three year appointment and Swackhamer's third term on the Council.

The University of Minnesota's **Onsite Sewage Treatment Program**, through a grant from the Minnesota Board of Water and Soil Resources and the Environment and Natural Resources Trust fund, developed a new spreadsheet-based model that calculates annual pollutant loads from problematic septic systems and accounts for the benefits of a range of septic system improvements, educational efforts and programs to identify the problematic systems. Local conservation partners can use this tool to report estimated improvements in pollution removals including Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), fecal coliform bacteria, phosphorus and nitrogen. Check out the new tool: Septic System Improvement Estimator and the Septic System Improvement Estimator Users Guide.

The University of Minnesota Water Resources Center (WRC) hosted a **Watershed Research Symposium** on February 21, 2013 to construct a water resources research agenda in Minnesota for the next five years, 2013 through 2018. Over 100 researchers, state decision makers, practitioners and citizen representatives met to discuss the current state of research in managing Minnesota's water resources and to identify gaps in information and knowledge that could be bridged through additional research.

"The issues facing Minnesota have not changed significantly but the need for research continues to grow. Groundwater is being recognized as a major issue by more water professionals and academics than it was five years ago," said **Faye Sleeper**, WRC co-director and symposium organizer.

Wetland Delinator Certification Program workshop season begins mid-June. Find the class schedule here: www.mnwetlands.umn.edu

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mmer 2013 Student News

Kyle Donovan received his M. S. Degree in December, 2012. His thesis was titled: Impacts of Perennial Vegetation and Restored Wetlands have on an Agricultural Watershed in Southwestern Minnesota. Donovan was advised by **Ken Brooks** and **Joe Magner**.

Jessica Eichmiller received her Ph.D. in November 2012. Her dissertation was titled: The Distribution and Persistence of Genetic Markers of Fecal Pollution on Lake Superior Beaches. Eichmiller was advised by **Mike Sadowsky** and **Randall Hicks**.

Joel Groten received his M. S. Degree in December 2012. His thesis was titled: Karst Hydrogeologic Investigation of Trout Brook, Dakota County, Minnesota. Groten was advised by **Calvin Alexander Jr.** and **Joe Magner**.

Matthew Kistner received his M. S. Degree in February 2013. His thesis was titled: Organic Carbon Reactivity in Lake Superior. Kistner was advised by **Sergei Katsev**.

Scott Kronholm was awarded The Doctoral Dissertation Fellowship Grant which provides $600 plus conference registration fee for Doctoral Dissertation fellows to present his work at one national or international conference during tenure on the fellowship. The Fellowship is intended to enable Ph.D. candidates of particular promise to devote full-time effort to the research and writing of their dissertation during 2013-14. Kronholm is advised by **Paul Capel**.

Amanda Strommer received her M. S. Degree February 2013. Her thesis was titled: Communication and Public Outreach about Emerging Contaminants In Public Drinking Water Supplies In Minnesota. Strommer was advised by **Kristen Nelson** and **James Almendinger**.

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mmer 2013 Resources and Publications

Photochemical Formation of Brominated Dioxins and Other Products of Concern from Hydroxylated Polybrominated Diphenyl Ethers (OH-PBDEs)

McNeill, K., W.A. Arnold, P.R. Erickson, and M. Grandbois. 2013

1st runner up for 2012 Science Paper of the year from Environmental Science & Technology

http://pubs.acs.org/doi/abs/10.1021/es401684v

Finding a path to Sustainable Water Management: Where We've been, Where We Need To Go

Enzler, S., S. Sutro Rhees and D.L. Swackhamer. 2013

William Mitchell Law Review, Volume 39, Number 3, pp.842-919.

Remediation to Improve Infiltration into Compact Soils

Olson, N.C., J.S. Gulliver, J.L. Nieber and M. Kayhanian. 2013

Journal of Environmental Management 117, 85-95.

http://dx.doi.org/10.1016/j.jenvman.2012.10.057.

Urban development usually involves soil compaction through converting large pervious land into developed land. This change typically increases runoff during runoff events and consequently may add to flooding and additional volume of runoff. The wash off of pollutants may also create numerous water quality and environmental problems for receiving waters. To alleviate this problem many municipalities are considering low impact development. One technique to reduce runoff in an urban area is to improve the soil infiltration. This study is specifically undertaken to investigate tilling and compost addition to improve infiltration rate, and to investigate measurement tools to assess the effectiveness of remediated soil.

Perfluoroalkyl Acids in Urban Stormwater Runoff: Influence of Land Use

Xiao, F., M.F. Simcik and J.S. Gulliver. 2012

Water Research, 46(20), 6601–6608.

http://dx.doi.org/10.1016/j.watres.2011.11.029 .

The Role of Biodegradation in Limiting the Accumulation of Petroleum Hydrocarbons in Raingarden Soils

LeFevre, G.H., R.M. Hozalski, and P.J. Novak. 2012

Water Research, 46(20), 6753–6762.

http://dx.doi.org/10.1016/j.watres.2011.12.040

Previous studies have indicated that raingardens are effective at removing petroleum hydrocarbons from stormwater. There are concerns, however, that petroleum hydrocarbons could accumulate in raingarden soil, potentially resulting in liability for the site owner. In this work, 75 soil samples were collected from 58 raingardens and 4 upland (i.e., control) sites in the Minneapolis, Minnesota area, representing a range of raingarden ages and catchment land uses.

Water Resources Sustainability Indicator: Application of the Watershed Characteristics Approach

Heidi M. Peterson, John L. Nieber, Roman Kanivetsky and Boris Shmagin. 2012 Springer

The quantification of the renewable flux (i.e. sustainable limit) of the hydrologic system is the prerequisite for transitioning from unsustainable to sustainable water resources management. The application of the Watershed Characteristics Approach to estimate the renewable flux of the hydrologic system was demonstrated using Minnesota's (USA) Twin Cities Metropolitan Area (TCMA). The methodology quantified the relationships between landscape properties and water balance characteristics, resulting in the development of functioning hierarchical hydrogeological units with corresponding recharge rates. This renewable flux is a key quantitative characteristic for the assessment of a sustainability indicator.

The Water Resources Center is a unit of the College of Food, Agricultural and Natural Resource Sciences and University of Minnesota Extension.

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